made generally known through the medium of the widely circulated journal NATURE, for on November 19, 1897, I sent photographic negatives to the office of NATURE for reproduction in that journal. These negatives showed the quartets as well as the pure sharp triplets and the diffuse triplets[1] which occur in the spectra of cadmium and zinc. They were produced by me in the end of October 1897, and were, I believe, the first photographic record of the actual magnetic tripling and quadrupling of the spectral lines. These negatives, however, were not considered suitable for reproduction in NATURE (see letter to NATURE, p. 173, December 23, 1897), but were subsequently enlarged and reproduced with great clearness in the *Philosophical Magazine* (April 1898).

In my letter to NATURE accompanying the negatives I did not dwell on the quartet form, as I did not wish to commit myself, or persuade others, to the belief that the quartet was really a magnetic quartet, *i.e.* produced exclusively by the magnetic field. It was quite open to belief at that time that the quartet form might be produced from the triplet by other mechanical causes, for example by reversal of the central line of the triplet, or in other ways, as noticed in my paper mentioned above. After prolonged effort I proved beyond all doubt that these variations of the triplet type (the quartet, &c.) are true magnetic perturbations, and are not due to any other cause; but this required *to be proved*, and for this purpose a very strong magnetic field was necessary.

With this field I found, as already announced in NATURE, that the quartet form becomes resolved into a sextet by the splitting up of the side lines into doublets. It is, therefore, not really a quartet after all, but a sextet.

With regard to other points, namely, the fact that the magnetic effect does not conform to the law deduced by the simple theory (viz. that $\delta\lambda \propto \lambda^2$), and the surmise that some such law might hold for groups of lines, a reference to my first paper, already mentioned (*Trans. Roy. Dub. Soc.*, December 22, 1897), will show both these points clearly emphasised there. On p. 387 I state that while some lines were converted into triplets "others photograph as doublets, or weak middled, greatly broadened lines, having the appearance of quartets; while on the other hand many lines appear to be simply broadened in the same magnetic field, and *others seem to be scarcely influenced in the same magnetic field*." Thus the effect appeared to be lawless for the spectral lines taken as a whole in any one substance; but I go on to say that "perhaps it might be possible to group the spectral lines of each substance into sets, so that some law of wave-length might apply to the lines of each set."

At this early date I was already seeking for some such law, and I had before the close of 1897 proved that the law, whatever it might be, was *not the same* as that which governs the pressural shift of the spectral lines studied by Messrs. Humphreys and Mohler (see *Proc. Roy. Soc.* of London, January 1898).

My search has resulted in the discovery of a general law which has so far proved to be in complete agreement with all the observed facts.

With regard to the spectrum of iron, you will observe in my note in the *Proc. Roy. Soc.*, January 1898, that I was at that early date of opinion that the spectrum of iron exhibited no peculiarities of its own in the magnetic field. I examined iron early because I thought that by reason of its magnetic properties its spectral lines might show some decided peculiarities (but iron is not magnetic above 700° C., therefore my hopes were not very decided). On the whole I still adhere to that opinion, for although the spectral lines of iron show a variety of effect, yet these effects are the same in character or in kind as those which are observed in other substances. This and other matters I have already treated of fully elsewhere (*Phil. Mag.* and NATURE).

The accompanying illustrations (Figs. 1, 2, 3) have been reproduced from the plate given in the memoir read before the Royal Dublin Society on December 22, 1897. They show that the quartets were observed and photographed by the author certainly before that date.

THOMAS PRESTON.

## NOTES.

DR. JANSSEN, director of the Meudon Observatory, has issued a circular in which he announces that the success of last year's observations of the Leonid meteors from a balloon has led to arrangements being made to repeat the experiment during the forthcoming shower. Last year, a number of these meteors were observed from a balloon above Paris, though the city itself was at the time enveloped in a thick fog. It is important that numerous observations of the Leonid meteors should be made from as many places as possible; and as balloons render observers independent of cloudy skies, they are evidently of great advantage upon occasions such as that to which astronomers are looking forward. We are informed that two balloon ascents are to take place near St. Denis. The first ascent will be made on the night of November 14-15, with the *Aerostat*, and the second, on the following night, with the *Centaure*. Two seats in each balloon will be at the disposal of Dr. Janssen, who will nominate observers to occupy them, without distinction of nationality. The names of the observers will be announced at the next meeting of the French Astronomical Society, on November 8.

THE opening meeting of the new session of the Institution of Electrical Engineers will take place on Thursday, November 16, when the premiums awarded for papers read or published during the session 1898-99 will be presented, and the president, Prof. Silvanus P. Thompson, F.R.S., will deliver his inaugural address.

A SERIES of monthly lantern lectures has been arranged by the Royal Photographic Society. The first lecture will take place on Tuesday, November 7, when Mr. J. J. Vezey will describe "Some Mediæval Towns of Germany," illustrated with slides by Commander C. E. Gladstone, R.N.

THE death of Mr. Grant Allen, at the age of fifty-one, removes one of the most popular of scientific authors whose writings have induced many readers to watch the workings of animate nature. His first scientific work, on "Physiological Aesthetics," was published in 1877, and was followed, in chronological order, by "The Colour Sense," "The Evolutionist at Large," "Vignettes from Nature," "Colours of Flowers," "Colin Clout's Calendar," "Flowers and their Pedigrees," "Charles Darwin," "Science in Arcady," "The Evolution of the Idea of God," &c. In addition, Mr. Allen contributed numerous articles on natural history topics to periodical literature. All his scientific articles and books are attractively composed, and they have been the means of imparting much popular instruction to general readers.

AMONG the privileges which the Hampstead Astronomical and Scientific Society is able to offer its members is the use of a reflecting telescope of 10½-inch mirror, which is erected in a small observatory on the East Heath, by permission of the London County Council. Interest in practical astronomy is aroused by this means, and the instructive lectures given at the meetings of the Society direct attention to facts and things terrestrial as well as celestial. A course of five lectures on astronomy will be given by Mr. P. E. Vizard in connection with the Society on Monday evenings, commencing on November 20. Mr. Vizard will also lecture on November 10, on the subject of the "November Meteors." A popular interest in, and practical study of, various branches of science is encouraged by the Society, and it is to be hoped that residents of Hampstead are actively supporting its efforts.

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[1] Really nonets as subsequently determined.

THE new session of the Royal Geographical Society will commence on Monday, November 13, when the president, Sir Clements Markham, will give a short opening address, to be followed by a paper by Mr. W. Rickmer Rickmers on his "Travels in Bokhara." The paper at the following meeting, November 27, will be by Mr. Vaughan Cornish on "Desert Sand Dunes." At the December meeting, Colonel Sir John Farquharson will probably give an "Account of the Past Twelve Years' Work of the Ordnance Survey," from the directorship of which he has recently retired. Other papers expected to be given during the session are: "An Ascent of Mount Kenya," by Mr. H. J. Mackinder; "The Work of the Yermak Ice-Breaker in the Spitsbergen Seas," by Admiral Makaroff; "Travels in Central Asia," by Captain H. H. P. Deasy; "Travels in the Region of Lake Rudolf and the Sobat River," by Captain Wellby; "Travels in Abyssinia," by Mr. H. Weld Blundell; and "Anthropogeography of British New Guinea," by Prof. Haddon.

THE *Journal* of the Society of Arts states that artificial paving stones are being successfully produced in Germany. The demand in all larger cities is said to be so good, and the expense attached to their production under former methods is so large, that any improvements on the older systems, whether in saving money or in producing a better stone, will be welcomed by almost all countries. The newest process in Germany is to mix coal-tar with sulphur and warm thoroughly; to the resulting semi-liquid mass chlorate of lime is added. After cooling, the mass is broken into small pieces, and mixed with glass or blast-furnace glass slag. This powder is then subjected to a pressure of 200 atmospheres, and reduced to the form or forms wanted. The resistance to wear and tear in use is fully half as great as that of Swedish granite. Thus it commends itself through durability equal to that of many stone roads, resistance to changes of temperature, roughness of surface—giving horses a good foothold—and, finally, non-transmission of sound. Inasmuch as the joinings are very small, dirt is avoided, and cleaning is very easy.

THE Institution of Mechanical Engineers commenced a series of monthly meetings on Friday last, when a paper was read by Mr. W. Ingham on the incrustation of iron pipes at the Torquay water works. The water supply is obtained from a tributary of the River Teign, which rises in the granite hills on a western spur of Dartmoor. The water is conveyed by two cast-iron mains to Torquay, one of them, laid in 1858, ten inches in diameter. At the time the pipes were laid, no one thought that the pure water from the Dartmoor hills would cause much deleterious action upon them. It was, therefore, with considerable surprise that at the end of eight years the delivering power of the mains was found to be reduced to 51 per cent. of their full discharging capacity. A scraper was designed, several years ago, to clean the pipes, and it is now regularly used. The scraper is pushed forward by the pressure of water acting upon pistons a little less in diameter than the diameter of the pipe. As it moves, the knives press outwards against the inside of the pipe and remove projecting nodules. The movement of the scraper through the pipes can be easily followed, when the mains are about three feet deep, by the rumbling noise it makes. The speed varies, of course, and is on the average about 2¼ miles per hour, but a speed of as much as 7½ miles per hour can be obtained for about three-quarters of a mile on one part of the line. After scraping in 1898, the delivery was increased from 586 to 708 gallons per minute, and similar results have been recorded for many years.

WATER engineers have to give very serious consideration to the subject of incrustations upon their mains. The deposit varies, of course, according to the nature of the water conveyed. When the water is derived from wells sunk in the chalk, the coating on the pipes is of pure calcium carbonate, which forms a desirable interior surface from one point of view, if not from the other of reduction of pipe area. Mr. W. Ingham states in his paper to the Institution of Mechanical Engineers that, speaking generally, it may be laid down with a fair approximation to the truth that well waters have not as great an action on pipes as those from upland gathering grounds, but where the water is soft the corrosive action will be greater. Filtered water has also a less corrosive power than unfiltered water. Whatever protective covering is applied to pipes, soft waters will cause rusting within a few years of being laid. At Torquay six years is the outside limit when this commences, so every precaution is taken to see that the pipes are well coated. Mr. Ingham remarks that though much has been done to get a satisfactory coating to pipes, there is still considerable room for improvement, and it is hardly necessary to point out that a fortune awaits the man who can invent something that will withstand the action of soft waters.

THERE seems to be some doubt as to the genuineness of a photograph which has been exhibited at the Royal Photographic Society (picture No. 357), as we gather from a letter published by Lieut.-General Tennant (*The British Journal of Photography*, October 13). Although the writer of this note has not seen the said picture, and therefore cannot describe it, General Tennant refers to it as "a very fine picture of clouds, but I am at a loss to understand how it can have been put forward as being like an eclipse of the sun." He states further that "high in the sky there appears a bright disc partly hiding a dark one surrounded by a bright halo . . . it is as though the bright sun were passing in front of the dark surface of the moon." General Tennant, at the time of writing his letter, stated that he was quite certain that it did not represent any phase of a solar eclipse either at Quetta (the place where the photograph was taken) or elsewhere; but in a more recent communication to the same journal (October 20) he is led to alter his opinion after seeing a photograph of the sun passing behind a church spire, saying that the peculiar appearance may possibly be the result of reversion. The latter opinion of General Tennant is no doubt the correct explanation of the abnormal appearance of the photograph in question, but the photographer of picture No. 357 may be glad to learn that a similar photograph was obtained at Sir Norman Lockyer's camp at Viziadrug, India, during the same eclipse. The camera used was a folding kodak, taking pictures 5 by 4 inches, and the exposures, four in all, were made by a blue-jacket. Each exposure lasted fifteen seconds, but, during the last, totality ended before the given time of exposure was concluded. This photograph shows the small crescent of the sun that appeared from behind the moon as black, while the disc of the moon is not black (as it appeared in the other three photographs), but nearly white, the density being just sufficient to differentiate between the corona and the moon's limb. This photograph is seemingly the same as No. 357, mentioned above, and its peculiarity is due, without doubt, to a reversal caused by the extreme brilliance of the uncovered portion of the sun.

THE photographic process of preparing textile designs, invented by Mr. Jan Szczepanik, was referred to by Prof. R. Beaumont in his opening address at the Yorkshire College, and is described in *Pearson's Magazine*. Prof. Beaumont has personally examined the invention, and has seen designs worked out by the new process in the premises of the Szczepanik Company at Paris. The object of the photographic appliances of Szczepanik is to take the artistic sketch, and, without any modification of the same, to enlarge it to scale, to transfer it on to ruled paper or point paper, and mark it with the thousands and millions of dots arranged in the proper orders for the development of the several parts of the pattern, in the weaves necessary for giving to each suitable precision of character when woven. Prof. Beaumont considers that the apparatus of Szczepanik is capable of producing designs in which there is considerable diversity of woven detail, so that it is purely a question of whether the designs thus obtained are legible for all practical purposes. There must of course be limitations to its utility, as there are to all automatic and mechanical appliances. Yet if it can be employed in accelerating the process of designing large patterns, it should have the serious attention of all who desire the further development of the weaving industries.

FROM a note in the *Journal* of the Society of Arts, it appears that there is reason to believe that in the near future mercury will be one of the most valuable of the numerous metallic products of New South Wales. Native quicksilver was found so far back as 1841 in the Cudgegong River, an auriferous stream, which flows through a portion of the western goldfields of the Colony. Cinnabar had previously been found in the same locality. Though efforts were made by the Rev. W. B. Clark to stimulate systematic research for the metal and its ores, little or nothing was done until later years, when cinnabar was found at several places, the richest deposits being discovered near Yulgilbar, in the Clarence River district, about four years ago. The Government geologist has inspected the workings in this locality, and has definitely ascertained the existence of three parallel lodes, which improve as they go down. Machinery is being erected, and a preliminary testing of about one thousand tons of ore will be made. Should the results prove satisfactory the New South Wales quicksilver trade will become revolutionised, as the poorest assays show the ore to be richer than those of the American and Spanish mines. They will also encourage the search for other cinnabar deposits, which, there is every reason for believing, are more numerous and richer than generally assumed. The value of the discovery in connection with the Colonial gold-mining industry can hardly be over-estimated. It simply means that the work of gold production will become enormously stimulated, thereby greatly increasing the already large auriferous output of the Colony.

THE summary of the *Weekly Weather Report* for the September quarter of the thirty-four years, 1866 to 1899, recently issued by the Meteorological Council, shows that mean temperature for both wheat-producing and grazing districts was 2° above the average. The only variations from these values were in the east and west of Scotland, where the excess was only 1°, and in the south and south-west of England, where the excess amounted to 3°. The general mean of the rainfall for the quarter was 2 inches below the average in both the above-mentioned districts; the principal variations were in the north and east of Scotland, where there was an excess of 1 inch, and in the south-west of England, where the deficiency amounted to 4 inches. Reckoning from January 1, the differences from the averages are less marked; in the east of Scotland, the north-west of England and south of Ireland, the excess amounts to about 2 inches, while in the east and south of England the deficiency amounts to 2·7 and 3·5 inches respectively.

DR. E. S. FATIGATI, of Madrid, has sent us a copy of an interesting pamphlet in which he deals with the representations of plants and animals, agricultural operations, and other natural objects and activities found in very old Spanish tombs, in cloisters of the eleventh and thirteenth centuries, corbels of churches, and choir stalls of the fifteenth century. It appears that the leaves, bunches of grapes, and tendrils of the vine, which were used as decorations during the classic period, are also found in the oldest Spanish sculpture of the sixth and seventh centuries. The animal world is well represented. The swan, the gallinaceous birds, the dog, and the lion make up the fauna of the little Asturian churches of the ninth century. In the magnificent cloister of Silos (eleventh century) the indigenous species are found by the side of those of oriental and northern origin. In the capitals of the cloister of Fawagona (beginning of the thirteenth century) are reproduced in stone two snakes devouring a frog, just as they may be seen doing every day in the ponds of the country. In addition, representations are found of the fight of a hunter with a bear of the Pyrenees, the capture of a hare by an eagle, and many others of the same kind. The pictures of nature with its beings and their struggle for life appear reflected in numerous monuments. From these and many other facts given in the pamphlet it seems that the Spanish sculptures of the Middle Ages have not an exclusive symbolic character, and that in those days Spain was not so separated from nature as many have supposed.

MR. JOHN BRILL, writing in the volume of *Proceedings* of the London Mathematical Society just issued, discusses the complete system of multilinear differential covariants of a single Pfaffian expression and of a set of such expressions. An account of the bilinear covariant of a Pfaffian expression is given by Forsyth; this covariant involves the first set of Pfaffians belonging to the given expression, from which latter it is derived by a differential operation. A repetition of this method upon the covariant itself merely produces an expression which vanishes identically. Mr. Brill shows how, by making use alternately of algebraic and differential methods of derivation, a series of covariants of the given expression can be produced which involve the various orders of derived functions associated with the expression. It is to be noted that the places at which differential operations occur are those which mark the passing from one group of cases into the next in the case of a set of equations obtained by equating the Pfaffian expressions severally to zero. Furthermore, the more general derived functions introduced by Mr. Brill play a similar part in regard to these latter covariants to that which the derived functions of a single expression play in reference to its covariants. One of the main difficulties of the subject is the extraordinary complication of the notation.

AN important paper on the development of the carapace of the Chelonia is contributed by Dr. A. Goette to the last number (vol. lxvi., part 3) of the *Zeitschrift für Wissenschaftliche Zoologie*, in the course of which the disputed question as to the relationship of the leathery turtles (Athecata) to the carapaced chelonians (Testudinata) is discussed. If the views put forward by Dr. Goette are correct, they will profoundly modify the generally accepted views as to the relations of the Athecata and Testudinata—more especially the late Dr. Baur's theory as to the former being a specialised group with a degenerate type of carapace.

IN the August number of the *Transactions* of the Connecticut Academy Mr. W. G. Vanhame records some recent experiments in regard to the fertilisation and development of the Planarians. From the ease with which these creatures can be kept in captivity and the number of eggs laid, observations on the development of the group would appear easy, but difficulties have been met with by previous observers, in consequence of which there are discrepancies and uncertainties in regard to many points. The unusually good preparations obtained by the author have enabled him to throw much new light on some of these disputed points. The eggs are laid in clusters or sheets containing from one to two dozens, arranged in a single layer and closely attached together with a white, mucus-like secretion, which is at first very sticky, although it subsequently hardens, Although hermaphrodite, Planarians reproduce by cross-fertilisation. For the details of the author's observations, reference must be made to the original paper.

In Prof. Verrill's report on the Ophiuroids collected during the Bahama Expedition of 1893 (*Bulletin from Iowa Laboratory*, vol. v., No. 1), the chief general interest centres round the observations connected with the protective resemblances developed by the feather-stars of the Bahamas. According to the author, "most of these species with long, coiled arms, adapted for clinging to the branches of gorgonian corals, are adapted for imitating closely, in various ways, the forms and colours of the corals on which they live. This must afford them a considerable degree of protection against predaceous fishes, in addition to the direct protection due to the stinging powers of the corals themselves, which is sufficient to cause most fishes to avoid them." Many fishes, it is added, have, however, in all probability become immune against coral-stings, and feed on hydroid polyps; and the author argues that if this be so, the additional protection afforded the feather-stars by their resemblance to the gorgonias would be obvious. But, unless the feather-stars form a specially tempting *bonne-bouche* and are liable to be picked off separately, the obviousness of this does not seem quite clear, since feather-stars and gorgonias would be both consumed together by the fish.

The importance now attached to preparing skins of small mammals for study purposes according to a uniform plan fully justifies the appearance of a paper on the subject by G. S. Miller in the *Bulletin* of the U.S. Museum (No. 39). A list of instruments and material required, as well as the details of manipulation, are given; and a plate illustrates the appearance of the finished specimens.

The November number of *Science Gossip* is particularly full of interesting articles. Major B. M. Skinner gives a short account of the valley of the Tochi river which he explored during the North-west Frontier campaign; and an account of the foraminifera collected by him from the rocks in Waziristan is given by Mr. Arthur Earland. The limestones fall naturally into two divisions, (1) alveoline, (2) nummulitic, and the article is illustrated by photographs of rock-sections of both of these types.

A series of observations on the "focal depth," or as it is sometimes called the penetrating power, of microscopic objectives is given by Mr. Leon E. Ryther in the *Journal of Applied Microscopy* for September. By plotting the magnifying powers of various combinations as abscissæ and the corresponding focal depths as ordinates, a curve is obtained approximating to an equilateral hyperbola indicating that in the author's experiments the focal depth varied inversely with the magnifying power.

J. Eriksson reprints from the *Annales des Sciences Naturelles* a translation of an important paper, which appeared originally in Swedish, on the brown rust of cereals. He proposes to split up into six species the well-known parasitic fungus *Puccinia rubigo-vera*, only one of which species is at present known in the æcidiospore stage. Of the six species described, the first and second only are of great importance in agriculture, the first being very destructive to rye, and the second being apparently the only parasitic fungus which causes rust on wheat in Europe, the United States or Australia. The paper concludes with some practical suggestions for farmers.

The mineral resources of the Province of New Brunswick form the subject of Part M of the tenth volume of the annual report of the Geological Survey of Canada (1899). The subject is dealt with by Dr. L. W. Bailey. At the outset he remarks that if we except building-stones, gypsum, limestone, brick-clays, and other materials applicable to building purposes, there are but four substances that have been the basis of anything like extended or successful mining operations. These are coal, iron, manganese and albertite, and of these coal only is at the present time being worked. There are, however, large tracts that are still covered with unbroken forest, and consequently are but little known. They comprise rocks whose geological age and character suggest that they may be productive of useful minerals.

A programme of lectures received from the Hull Scientific and Field Naturalists' Club shows that the Club is actively engaged in creating and fostering a love of natural knowledge within its sphere of influence.

During this month the following popular science lectures will be delivered on Tuesday evenings, at the Royal Victoria Hall:—November 7, Mr. L. Fletcher, F.R.S., on "The Fall of Stars from the Sky"; November 14, Mr. W. J. Pope, on "The Uses of Distillation"; November 21, Dr. J. W. Waghorn on "Bad-Contacts: their application to telephones and wireless telegraphy"; November 28, Mr. Michael Sadler on "A Brother of the Birds" (St. Francis of Assisi).

The *London Quarterly Review* (Charles H. Kelly) publishes a long article by "A Field Naturalist," in which Darwin's observations and experiments on cowslips and primroses are discussed, and the conclusion is arrived at that the evidence brought forward by him is insufficient to establish the theory that cross-fertilisation is necessary to the full fertility of flowers. "On the contrary," says the reviewer, "we are of opinion that the primrose gives strong confirmatory evidence to Axell's view, that under natural and equal conditions, self-fertilisation of flowers is both the legitimate fertilisation and the most productive."

A natural consequence of the scientific activity of the Liverpool Marine Biology Committee is the preparation of a series of memoirs, edited by Prof. Herdman, on typical British marine plants and animals. Each memoir will be concerned with one type, and the forms selected for description will chiefly be common Irish Sea animals and plants, of which no adequate account already exists in text-books. Three of the memoirs will appear before the end of this year, namely, Ascidia, by Prof. Herdman; Cockle, by J. Johnstone; and Echinus, by H. C. Chadwick. Others will follow in rapid succession, and the complete series of special studies promises to be of value to all marine biologists.

The additions to the Zoological Society's Gardens during the past week include a Sooty Mangabey (*Cercocebus fuliginosus*) from West Africa, presented by the Rev. A. Clutterbuck; a Young Leopard (*Felis pardus*) from East Africa, presented by Captain J. L. Stanistreet; a Greater Vasa Parrakeet (*Coracopsis vasa*) from Madagascar, presented by Mr. C. Hunt; a Corn Crake (*Crex pratensis*), British, presented by Mr. Collingwood Ingram; a Ring-hals Snake (*Sepedon haemachetes*) from South Africa, presented by Mr. J. E. Matcham; two Red-footed Lemurs (*Lemur rufipes*, ♂ ♀) from Madagascar, an Ichneumon (*Bdeogale*, sp. inc.) from Africa, a Westerman's Eclectus (*Eclectus westermani*) from Moluccas, two Black-tailed Godwits (*Limosa aegocephala*), European; ten Salt-water Terrapins (*Malacoclemmys terrapin*) from North America, deposited; four Common Squirrels (*Sciurus vulgaris*), European, purchased.